

Executive Summary

Design principles of a functional ward and their impact on staff and patients

Citation Yap G., Garrubba M., Melder A. Design principles of a functional ward and their impact on staff and patients: Scoping Review. Centre for Clinical Effectiveness, Monash Innovation and Quality, Monash Health, Melbourne, Australia.

Abstract

Background

The Ward Redesign Working Group, chaired by General Manger, Acute Medicine has requested a review of evidence on ward design principles to inform decision-making. The Chair plans for the design principles to go to the transforming care forum and site forums for agreement. During stakeholder consultation, certain factors of interest were highlighted. The review will report these factors as available in literature.

Questions

1. What is the evidence to support design principles of functioning wards?
2. How effective are ward design principles in improving patient outcomes (satisfaction, experience, behaviour, length of stay, infection, pain) and staff outcomes (satisfaction)?

Methodology

An iterative database search was performed in Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, Ovid MEDLINE and Versions(R); All EBM and Google to identify synthesised literature published between 2012-2017. Documents were screened according to the inclusion criteria (Table 3) and quality of included articles were appraised.

Results

Seven resources were identified: three systematic reviews [1-3], and four items of grey literature (research that is either unpublished or has been published in non-commercial form). [4-7]. Table 1 summarises the evidence identified in detail.

Ward design principles across wards

Ward design principles, supported by evidence from two or more studies, applied across wards include:

- Ambient features (i.e., sunlight, lighting) [1]
- Architecture (i.e., room size, single room layout, space, grab bars, bathroom and toilet location, flooring, separate family room, work stations) [2]
- Meaningful engagement (i.e., art, audiovisual distraction) [3]
- Multifaceted interventions (whole unit design) [4].

Findings were from three systematic reviews of moderate to high quality [1-3], and one quality improvement cross-sectional study [4]. The interventions (such as art, audio visual distraction, room size, single room layout, space, grab bars, bathroom and toilet location, flooring, separate family room, work stations) were evaluated by only a few (2 to 4) low to moderate quality studies indicating a generally weak body of evidence of effect. Having said that positive impact on patient's pain, satisfaction, infection rate, length of stay or falls was reported. (Table 1)

Ward design principles for environments to support patients with dementia

Ward design principles that support dementia patients include: Unobtrusively reduce risks [5], provide a human scale [5], allow people to see and be seen [5], reduce unhelpful stimulation [5], optimise helpful stimulation / wayfinding / orientation [5,6], support movement and engagement / meaningful activity [5,6], create a familiar space / familiarity [5,6], provide a variety of spaces to be alone or with others / legibility [5,6] provide links to the community [5], and support the values and goals of care. The evidence base to support these principles is weak, and not all have been evaluated for their outcomes on patients or staff [5].

Evaluation findings from The King's Fund's Enhancing the Healing Environment (EHE) programme highlight the importance of supportive design for dementia in improving patient outcomes (reducing falls and aggressive behaviour) and staff outcomes (increased satisfaction). (Table 2)

Table 1. Summary of overarching ward design principles supported by evidence from two of more studies for each outcome

Ward Design Principles & interventions	Patient Outcome	Positive Effect	Quality of Evidence	Reference
1. Ambient features				
Sunlight/Lighting	Pain	Mixed*	Low-high	[1,2]
	Falls	N	Low	[4]
Air quality	Infection	N	Low	[1]
2. Meaningful engagement				
Art	Satisfaction	Y	Not described	[2]
Audiovisual	Pain	Y	Low	[1]
3. Architectural features				
Room size	Infection	Y	Not described	[3]
Single room	Infection	Y	Not described	[3]
	Falls	Y	Low	[4]
Space	Pain	Y	Not described	[2]
	Falls	N	Low	[4]
Grab bars	Falls	Y	Low	[4]
Location of bathroom/toilet	Falls	Y	Low	[4]
Flooring	Length of stay	N	Moderate	[1]
	Falls	Y	Low	[4]
Family area/room	Falls	Y	Low	[4]
Work station	Falls	N	Low	[4]
4. Multi-faceted interventions				
Whole unit design	Length of stay	N	Moderate	[1]

Note: * Heterogeneous outcomes of effect

Table 2. Ward design principles for environments to support people with dementia and evaluated outcomes

Ward Design Principles	Outcomes	Positive Effect	Type of Evidence	Reference
1. Legibility 2. Orientation 3. Wayfinding 4. Familiarity 5. Meaningful activity	Patient falls	Y	Quality improvement project	[6]
	Patient behaviour: violence	Y	Quality improvement project	[6]
	Patient behaviour: agitation	Y	Quality improvement project	[6]
	Staff satisfaction	Y	Quality improvement project	[6]

Conclusion

Overall the evidence base supporting ward design principles is limited, and the evidence of ward design principles resulting in positive patient and staff outcomes is weak. Where described, evidence is based on a small number of low quality studies which include randomised controlled trials, case control trials, and quality improvement studies.

Nevertheless, evaluation findings from work supported by The King's Fund demonstrate an improvement in patient outcomes (i.e., reducing falls and aggressive behaviour) and staff outcomes (i.e., an increased satisfaction) following environmental redesign, highlighting the importance of a supportive ward design for dementia patients [6]. The Centre for Health Design also highlights practical interventions (i.e., two grab bars, bathroom location, toilet orientation, vinyl flooring, separate family room) that have been shown to reduce patients falls in participating hospitals [4], however these should be considered with caution as the paper is considered to have a high risk of bias with limited generalisability.

The Australasian Health Facility Guidelines document describes overarching principles of healthcare facility design which aims are to provide a benchmark for the designer, checklist for design and functionality, or as a source of information for user [7].

During stakeholder consultation, information on the following areas of interest were requested: toilet seats, handrails, compactus style, drug room layout, write up desks, bedside charts, and possible linkages to the electronic medical record; however no synthesised evidence reported the impact of these design interventions.

Background

The Ward Redesign Working Group, chaired by General Manger, Acute Medicine has requested a review of evidence on ward design principles to inform decision-making. The Chair plans for the design principles to go to the transforming care forum and site forums for agreement. During stakeholder consultation, certain factors of interest were highlighted. The review will report these factors as available in literature.

Questions

1. What is the evidence to support design principles of functioning wards?
2. How effective are ward design principles in improving patient outcomes (satisfaction, experience, behaviour, length of stay, infection, pain) and staff outcomes (satisfaction)?

Scope

This review focuses only on physical (environment) principles to the ward design in hospitals. We excluded therapeutic interventions (such as aromatherapy, music, art activities or any services delivered within the wards). During stakeholder consultation, information on the following areas of interest were requested: delirium and dementia requirements, painting of walls, toilet seats, handrails, compactus style, drug room layout, write up desks, bedside charts, and possible linkages to the electronic medical record.

Search Methods

Inclusion and exclusion criteria

Table 3. Inclusion/exclusion criteria

Setting	<i>Include:</i> All hospital wards; Adult <i>Exclude:</i> Other settings								
Intervention	<i>Include:</i> Environmental (physical) interventions <i>Exclude:</i> Other interventions (i.e., services, activities, any therapies)								
Outcome	<table style="width: 100%; border: none;"> <tr> <td style="width: 50%;">Patient outcomes</td> <td style="width: 50%;"> <ul style="list-style-type: none"> • Infection </td> </tr> <tr> <td> <ul style="list-style-type: none"> • Satisfaction • Experience • Violent behaviour • Length of stay (LOS) </td> <td> <ul style="list-style-type: none"> • Pain • Falls </td> </tr> <tr> <td></td> <td>Staff outcomes</td> </tr> <tr> <td></td> <td> <ul style="list-style-type: none"> • Staff satisfaction </td> </tr> </table>	Patient outcomes	<ul style="list-style-type: none"> • Infection 	<ul style="list-style-type: none"> • Satisfaction • Experience • Violent behaviour • Length of stay (LOS) 	<ul style="list-style-type: none"> • Pain • Falls 		Staff outcomes		<ul style="list-style-type: none"> • Staff satisfaction
Patient outcomes	<ul style="list-style-type: none"> • Infection 								
<ul style="list-style-type: none"> • Satisfaction • Experience • Violent behaviour • Length of stay (LOS) 	<ul style="list-style-type: none"> • Pain • Falls 								
	Staff outcomes								
	<ul style="list-style-type: none"> • Staff satisfaction 								
Publications details	<i>Inclusion:</i> Synthesised literature from systematic reviews, meta-analyses, guidelines, white papers <i>Exclusion:</i> Other types of studies, book chapters, theses, opinions								
Limitation	2012-2017; Published in English; Humans								
Databases	Ovid MEDLINE(R) Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, Ovid MEDLINE and Versions(R); All EBM; Google								

Document Selection

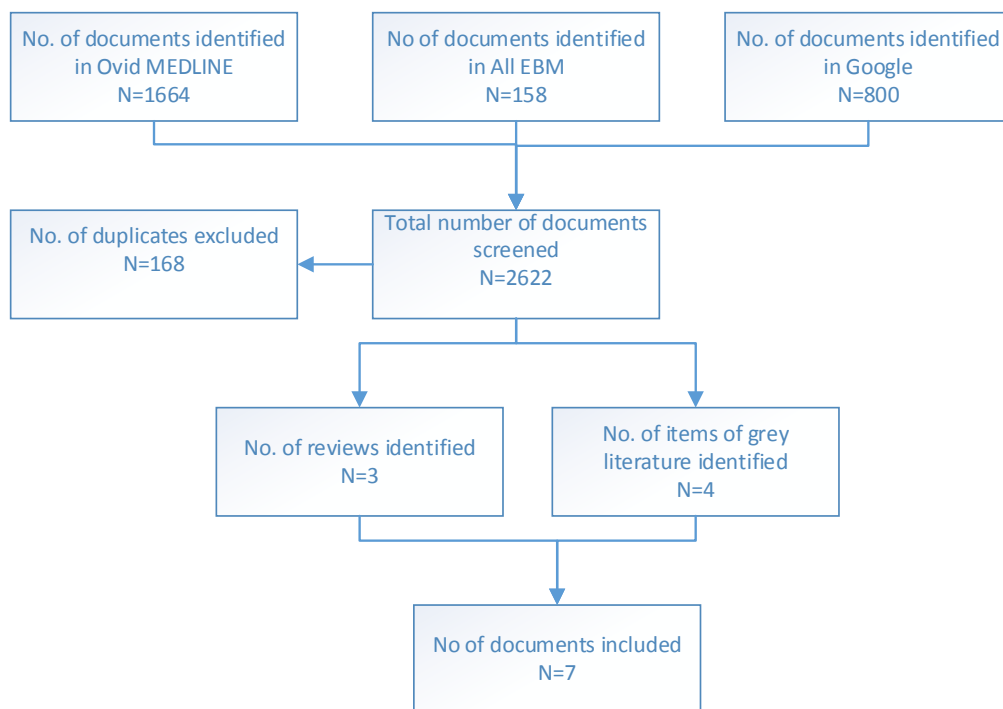
Search methodology was decided *a priori* and was performed in two medical databases and Google according to the inclusion and exclusion criteria (Table 3). References were exported and screened in Endnote X7 (Thompson, Reuters, Carlsbad, California, USA) by one reviewer (GY). Only synthesised data (i.e., reviews, meta-analyses, white papers) were selected in the first stage of screening. In the second stage of screening, an iterative approach to selecting and extracting data was adopted; the stakeholder/end user was consulted and search methodology was then refined where necessary.

Assessment of Quality of Included Literature

Included documents were appraised for their quality based on the following four criteria: 1) An appraisal of the quality of included studies was done; 2) Inclusion and exclusion criteria was detailed; 3) A clear search strategy detailing the search terms, and date limitations was included; 4) The document had a clear research question and aim.

Search Results

Figure 1. Flow diagram of the search results.



Database search

The databases search resulted in 1664 documents which were exported to Endnote.

Screening

Duplicates were deleted and a total of 2622 articles were screened. Title and abstract were screened according to the inclusion criteria for selection.

Document selection

Four items of grey literature and three systematic reviews were selected for inclusion in the review.

Description of included studies

A total of seven documents were selected for inclusion. (Figure 1)

Five documents provide evidence to support ward design principles and interventions across ward environments: one high quality Cochrane systematic review [1]; two moderate quality systematic reviews and meta-analyses [2,3] that evaluated the impact of ward environments on patient outcomes (i.e., infection, satisfaction, experience, pain, length of stay); one quality improvement study conducted by the Centre for Health Design evaluating the impact of the built environment on patient fall rates [4]; and an Australasian Health Facility Guidelines published by the Australasian Health Infrastructure Alliance [7].

Two documents described ward design principles to support dementia patients: an evidence-based document published by NSW Agency for Clinical Innovation – Aged Health Network describing ten principles of ward design to support dementia patients [5]; and one white paper published by The King's Fund that evaluated a program which applied five principles of ward design to environments to support dementia patients and reported its effect on patient and staff outcomes [6].

Description of Results

Four documents provided evidence to support design principles in improving staff or patient outcomes [1-4]. Design principles that were evaluated by two or four studies per outcome are summarised and included in Table 3.

Ward design principles and their Impact on patient outcomes

Findings from three recent systematic reviews of moderate to high quality [1-3], and one quality improvement cross-sectional study [4], demonstrate that limited evidence is available to support the following principles or interventions in having a positive impact on patients pain, satisfaction, infection rate, length of stay or falls: ambient features (i.e., sunlight, lighting), meaningful engagement (i.e., art, audiovisual distraction), architecture (i.e., room size, single room layout, space, grab bars, bathroom and toilet location, flooring, separate family room, work stations) and multifaceted interventions (whole unit design). Table 4 provides a description of ward principles and reported outcomes that were supported by evidence from two or more of its included studies.

Table 3. Summary of overarching ward principles and interventions (evaluated by two of more studies) and reported outcomes

Ward Design Principles & interventions	Patient Outcome	Positive Effect	Quality of evidence	Reference
1. Ambient features				
Sunlight/Lighting	Pain	Mixed*	Low-high	[1,2]
	Falls	N	Low	[4]
Air quality	Infection	N	Low	[1]
2. Meaningful engagement				
Art	Satisfaction	Y	Not described	[2]
Audiovisual	Pain	Y	Low	[1]
3. Architectural features				
Room size	Infection	Y	Not described	[3]
Single room	Infection	Y	Not described	[3]
	Falls	Y	Low	[4]
Space	Pain	Y	Not described	[2]
	Falls	N	Low	[4]
Grab bars	Falls	Y	Low	[4]
Location of bathroom/toilet	Falls	Y	Low	[4]
Flooring	Length of stay	N	Moderate	[1]
	Falls	Y	Low	[4]
Family area/room	Falls	Y	Low	[4]
Work station	Falls	N	Low	[4]
4. Multi-faceted interventions				
Whole unit design	Length of stay	N	Moderate	[1]

Note: * Heterogenous outcomes of effect

Ward design principles to support dementia-friendly environments and their impact on patient and staff outcomes

Two articles describe ward principles for environments that support dementia patients [5, 6] (Appendix 1, Table 10).

Ward design principles that support dementia patients include: Unobtrusively reduce risks [5], provide a human scale [5], allow people to see and be seen [5], reduce unhelpful stimulation [5], optimise helpful stimulation / wayfinding / orientation [5,6], support movement and engagement / meaningful activity [5,6], create a familiar space / familiarity [5,6], provide a variety of spaces to be alone or with others / legibility [5,6] provide links to the community [5], and support the values and goals of care. The evidence base to support these principles is weak, and not all have been evaluated for their outcomes on patients or staff [5].

The King's Fund Enhancing the Healing Environment (EHE) programme – Environments of Care for People with Dementia involved the redesign of acute wards, entrance and social spaces, improvements to corridors, dayrooms, balcony and gardens spaces in both acute and mental health settings. Outcomes from this quality improvement work are found in Table 5 [6]. The NSW Agency for Clinical Innovation – Aged Health Network recommend ten principles of ward design to support dementia patients. Table 6 describes these ten principles supported by evidence from two or more studies for each outcome.

Overarching principles for healthcare facility design that were not evaluated for their effectiveness

The Australasian Health Facility Guidelines document describes overarching principles of healthcare facility design which aims are to provide a benchmark for the designer, checklist for design and functionality, or as a source of information for user [7]. (Appendix 1, Table 10)

Synthesis of Results

Table 4. Ward design principles and interventions supported by evidence from two or more studies for each outcome

Principles	Results for outcomes of interest	Quality of studies results are based on
1. Ambient features (non-permanent)		
Sunlight/Lighting	<p><u>Pain</u></p> <ul style="list-style-type: none"> Spacious, friendly, light-flooded hospital architecture may improve pain – predominantly in psychiatric wards [2] No strong evidence for the effect of lighting on the outcome of pain [1] <p><u>Falls</u></p> <ul style="list-style-type: none"> There was no evidence that nightlights, number of lights the patient can control, or lighting had an impact on falls. [4] 	<p>4 studies; quality not described</p> <p>1 Case control trial (CCT) – good quality</p> <p>Quality improvement project in 12 hospitals</p>
Air Quality	<p><u>Infection</u></p> <ul style="list-style-type: none"> Found no strong evidence of an effect for number of septic episodes, presence of resistant bacteria, and acquisitions of <i>Staphylococcus aureus</i>. [1] 	<p>1 Randomised controlled trial (RCT), 2 CCTs – poor quality</p>
2. Engagement of meaningful activity (distractors)		
Art (including images of nature or artwork)	<p><u>Patient Satisfaction</u></p> <ul style="list-style-type: none"> “magic windows” presenting scenes from nature installed on the ceilings and walls in the waiting area and hallways increased patient satisfaction and overall hospital experience [2] 	<p>3 studies; quality not described</p>
Audiovisual distractions Versus Standard Care	<p><u>Pain</u></p> <ul style="list-style-type: none"> Significantly in favour of audiovisual distraction [1] 	<p>3 studies – poor quality</p>
3. Architectural features (permanent)		
Patient’s room size	<p><u>Infection</u></p> <ul style="list-style-type: none"> Analysis showed a significant risk of infection with <i>Clostridium difficile</i> associated with a median of 191 square footage compared to 180 square footage [3] 	<p>3 studies; quality not described</p>

Principles	Results for outcomes of interest	Quality of studies results are based on
	<u>Severe acute respiratory syndrome (SARS)</u> <ul style="list-style-type: none"> A minimum distance between beds of $\leq 1\text{m}$ was a significant risk factor associated with health-care associated outbreaks of SARS at all participating hospital wards [3] 	
Single patient rooms	<u>Infection</u> Single-patient room seems to have a significant benefit in reducing the healthcare-associated colonization with MDRO and the infection rate with any pathogen compared to multiple patient bedrooms [3]	3 studies; quality not described
	<u>Falls</u> Twice as many falls occurred in shared rooms as compared to that in private rooms ($p < 0.027$).	Quality improvement project in 12 hospitals
Space	<u>Pain</u> <ul style="list-style-type: none"> Spacious, friendly, light-flooded hospital architecture may improve pain - predominantly in psychiatric wards [2] 	4 studies; quality not described
	<u>Falls</u> <ul style="list-style-type: none"> There was no evidence that storage for wheelchair or walkers had an impact on falls. [4] 	Quality improvement project in 12 hospitals
Grab bars	<u>Falls</u> <ul style="list-style-type: none"> There were more falls when there was only one wall-mounted grab bar in the bathroom ($p < 0.000$). [4] At the toilet, having two grab bars, one on each side, appears to help prevent falls over having grab bars mounted on the walls of the bathroom. Almost four times more falls occurring with wall-mounted grab bars as when there are grab bars on both sides of the toilet. [4] 	Quality improvement project in 12 hospitals
Location of bathrooms and toilets	<u>Falls</u> <ul style="list-style-type: none"> Toilet located on a sidewall in the bathroom was associated with fewer falls than when the toilet was directly across from the entrance ($p < 0.032$). [4] Falls per 1,000 patients days were higher ($\mu = 0.0132$) when the bathroom was located on the headwall than on the footwall ($\mu = 0.0090$, $p < 0.039$). [4] 	Quality improvement project in 12 hospitals
Flooring	<u>Length of stay</u>	

Principles	Results for outcomes of interest	Quality of studies results are based on
	<ul style="list-style-type: none"> No strong evidence of an effect between linoleum flooring and carpeted flooring groups on length of stay. [1] <p><u>Falls</u></p> <ul style="list-style-type: none"> Linoleum flooring in the bedroom was associated with significantly more falls than either vinyl composition tile (VCT) or vinyl ($p < 0.000$); rate of falls was 10 times higher for linoleum flooring than for VCT or ceramic tile in bathrooms [4] 	<p>2 RCTs – moderate quality</p> <p>Quality improvement project in 12 hospitals</p>
Designated family area/room	<p><u>Falls</u></p> <ul style="list-style-type: none"> A key finding is that there are roughly half as many falls in patient rooms that have a designated family area as rooms that have no designated family area ($p < 0.01$). [4] 	Quality improvement project in 12 hospitals
Work stations	<p><u>Falls</u></p> <ul style="list-style-type: none"> The rate of falls was significantly higher* ($p < 0.000$) for rooms with direct visibility to commonly occupied workstations than to infrequently used workstations. [4] <p>*The finding of higher numbers of falls in rooms with staff visibility is undoubtedly confounded by where high fall-risk patients are placed within the unit. Further, there may have been discrepancies in what was recorded and reported as a fall between different hospitals.</p> <p>Since the data were retrospective, and hospitals differed on what data they record at the time of the fall, it is possible that differences in data collection impacted the number of falls reported, leading to either an under- or over-reporting of incidents.</p>	Quality improvement project in 12 hospitals
4. Multi-faceted interventions		
Whole Unit design	<p><u>Length of stay</u></p> <ul style="list-style-type: none"> No strong evidence of an effect for length of stay between a refurbished wing group and a traditional wing group [1] 	2 CCTs – moderate quality [1]

Table 5. Outcomes from quality improvement work in 23 NHS trusts in the latest phase of the Enhancing the Healing Environment (EHE) programme – Environments of Care for People with Dementia [6]

Design principles	Results for outcomes of interest
<ul style="list-style-type: none"> 1) Legibility (the ability to understand spaces) 2) Orientation 3) Wayfinding 4) Familiarity 5) Meaningful activity. 	<p>Stage 1 evaluation: 3-6 months post intervention in five mental health trusts demonstrate a reduction in falls, and in the use of anti-psychotic medication, fewer incidents of violence and aggression, and improved recruitment and retention of staff.</p> <p>Stage 2 evaluation: 6 month post-intervention in five acute general hospitals, and five mental health and community hospitals demonstrate the following impact on patient outcomes and staff outcomes:</p> <p><u>Patient Falls</u></p> <p>Proportion of falls in the refurbished areas had fallen from 36% to 26% in lounge, corridors or social spaces.</p> <p>Opaque glass film to semi-obscure bed bays improves privacy and dignity so that people no longer feel that they are in a goldfish bowl.</p> <p><u>Patient behaviour</u></p> <p>This shows that in eight trusts, incidents of violence and aggression went down post intervention.</p> <p>The rate of decrease in violent and aggressive incidents was greater in the intervention ward than in the comparator.</p> <p><u>Patient outcomes</u></p> <p>Calmer, well-lit and more legible environments, with good signage, help people feel less agitated and more able to navigate unfamiliar places.</p> <p><u>Staff outcomes</u></p> <p>Staff sickness and absence were used as indicators of staff satisfaction. Sickness and absence rates were lower in intervention wards than their comparators in the same trusts.</p>

Table 6. Ward design principles and interventions to support people with dementia based on evidence from two or more studies for each outcome [5]

Principle	Intervention	Outcome	Quality of studies results are based on
Unobtrusively reduce risks	Unobtrusive safety barrier (around perimeter)	<u>Patient satisfaction</u> Patients may respond negatively to a safety or security measure if it impedes their freedom; this is mitigated by providing these unobtrusively (i.e., hide fence with shrub)	2 studies; quality not discussed [5]
Provide a human scale	Split facility into clusters (i.e., Special care units)	<u>Quality of care</u> High quality care is easier to provide in small groups. <u>Patient outcomes</u> Evidence tends to suggest that the best outcomes occur when the resident lives in a small unit but has access to a larger social network.	2 studies; quality not discussed [5] 3 studies; quality not discussed [5]
	Reduce patient density	<u>Patient experience</u> Domestic scale and feel have been recommended in the acute care setting in order to make the inpatient experience more familiar and less confusing.	3 study; quality not discussed [5]
Allow people to see and be seen	Good visual access of staff and patients	<u>Patient behaviour</u> The design plan built by NSW Department of Health was shown to improve self-help, socialisation and behaviour, and improved orientation. Disorientation was less pronounced in “L”, “H” and square shaped units.	4 studies; quality not discussed [5]
Reduce unhelpful stimulation	Minimise noise and distractions	<u>Patient behaviour</u> Patients are less aggressive where sensory input (including acoustics) of the inpatient environment is controlled.	2 studies; quality not discussed [5]
Optimise helpful stimulation	Enhance wayfinding	<u>Patient behaviour</u> Providing signs to assist wayfinding has been associated with improved patient behaviour. Display of personal memorabilia outside rooms or use of colour have some benefit.	3 studies; quality not discussed [5]
	Lighting	<u>Patient experience</u>	

		Increasing illumination to normal has been shown to regulate circadian rhythms and improved sleep patterns for people with dementia <u>Patient behaviour</u> High levels of illumination are associated with increased agitation in people with dementia.	2 studies; quality not discussed [5] 3 studies; quality not discussed [5]
Support movement and engagement	Access to areas of comfort and interest	<u>Patient experience</u> Access to an outside area of interest (via walking path) is associated with reduced sadness, increased pleasure and lower levels of agitation.	2 studies; quality not discussed [5]
Create a familiar space	Introduce familiar finishes, objects and colours	<u>Patient behaviour</u> Making the healthcare environment as familiar as possible has been recognised as contributing to avoidance of agitation and disorientation.	2 studies; quality not discussed [5]
Provide a variety of spaces to be alone or with others	Access to an alternative space in unit	<u>Patient behaviour</u> Residents with the opportunity to enjoy privacy were less anxious and aggressive and those who had access to a variety of common spaces with varying ambiance were less socially withdrawn and depressed. <u>Patient experience</u> Patients in special care units have been described as enjoying the opportunity to be alone and in social spaces.	1 study; quality not discussed [5] 1 study; quality not discussed [5]
	Single patient rooms	<u>Patient experience</u> Single rooms are important for most people with dementia in that they provide them with an opportunity to withdraw when they feel threatened.	2 studies; quality not discussed [5]
Provide links to the community	Provide spaces for visitors and interaction with community	Despite the increasing attention to the role of the community in supporting people with dementia no empirical investigations of the advantages have been found	[5]
Support the values and goals of care	Clearly state values and goals to guide decisions on the design of the built environment	<u>Patient outcomes</u> A systematic review of over 600 studies in mental healthcare concluded that exposure to the arts may reduce anxiety and depression in specific groups of patients. There is evidence that the arts can positively affect clinical and behavioural outcomes.	1 systematic review; quality not discussed [5]

Conclusions

Overall the evidence base supporting ward design principles is limited, and the evidence of ward design principles resulting in positive patient and staff outcomes is weak. Where described, evidence is based on a small number of low quality studies which include randomised controlled trials, case control trials, and quality improvement studies.

Nevertheless, evaluation findings from work supported by The King's Fund demonstrate an improvement in patient outcomes (i.e., reducing falls and aggressive behaviour) and staff outcomes (i.e., an increased satisfaction) following environmental redesign, highlighting the importance of a supportive ward design for dementia patients [6]. The Centre for Health Design also highlights practical interventions (i.e., two grab bars, bathroom location, toilet orientation, vinyl flooring, separate family room) that have been shown to reduce patients falls in participating hospitals [4]; however these should be considered with caution as the paper is considered to have a high risk of bias with limited generalisability.

The Australasian Health Facility Guidelines document describes overarching principles of healthcare facility design which aims are to provide a benchmark for the designer, checklist for design and functionality, or as a source of information for user [7].

During stakeholder consultation, information on the following areas of interest were requested: toilet seats, handrails, compactus style, drug room layout, write up desks, bedside charts, and possible linkages to the electronic medical record; however no synthesised evidence reported the impact of these design interventions

Limitations

Findings in this report that evaluated outcomes to support ward design principles were based on low strength of evidence from synthesised peer-reviewed literature, only one of which was of high quality [1], as well as grey literature. The findings reported by grey literature should be interpreted with caution. The development (i.e., search strategy or inclusion criteria) of the Australasian Health Facility Guidelines (AIHA) or the evidence base from the Agency for Clinical Innovation Aged Health Network [5] were not clearly described. This limits the applicability and strength of the recommendations made. The evaluation of the effectiveness of principles and interventions by the Centre for Health Design was based on a retrospective cross-sectional study design. This subjected data to a high risk of bias and limits the generalisability of the recommendations [4].

References

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- 2) Vetter D, Barth J, Uyulmaz, S et. al. Effects of Art on Surgical Patients: A Systematic Review and Meta-analysis. *Ann Surg* 2015; 262:704–713.
- 3) Stiller A, Salm F, Bischoff P and Gastmeier P. Relationship between hospital ward design and healthcare-associated infection rates: a systematic review and meta-analysis. *Antimicrobial Resistance and Infection Control* 2016; 5:51.
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- 5) Agency for Clinical Innovation (ACI) Aged Health Network. Key Principles for Improving Healthcare Environments for People with Dementia. Published in 2014.
- 6) Waller S, Masterson A. and Finn H. Developing Supportive Design for People with Dementia. The King's Fund's Enhancing the Healing Environment Programme 2009-2012. Published in 2013 by The King's Fund.
- 7) Australasian Health Infrastructure Alliance. Australasian Health Facility Guidelines: Part C - Design for Access, Mobility, OHS and Security. Revision 5.0. 01 March 2016.

Appendix 1

Table 7. Ovid MEDLINE Database search (performed on 6 Sep 2017)

Search terms in Ovid Medline Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Ovid MEDLINE(R) Daily, Ovid MEDLINE and Versions(R)	
1	*Psychophysiology/
2	*Hospitalization/
3	*Pain/
4	*Patient Satisfaction/
5	*Health Personnel/ or *"Attitude of Health Personnel"/
6	*Health Manpower/
7	*Patient Care Team/
8	*Quality of care/
9	anxiety.ab. or anxiety.ti.
10	stress.ab. or stress.ti.
11	*length of stay/
12	recovery time.ab. or recovery time.ti.
13	hospital acquired infection?.ab. or hospital acquired infection?.ti.
14	hospital associated infection?.ab. or hospital associated infection?.ti.
15	OR (#1 – #14)
16	*Art/
17	*Color/
18	*Color Therapy/
19	OR (#16 – #18)
20	healing design?.ab. or healing design?.ti.
21	therapeutic design?.ab. or therapeutic design?.ti.
22	restorative design?.ab. or restorative design?.ti.
23	healing environment?.ab. or healing environment?.ti.
24	therapeutic environment?.ab. or therapeutic environment?.ti.
25	restorative environment?.ab. or restorative environment?.ti.
26	*Environment Design/
27	*"Hospital Design and Construction"/
28	ward environment.ab. or ward environment.ti.
29	ward design.ab. or ward design.ti.
30	*Health Facility Environment/
31	*Air Conditioning/
32	temperature.sh.
33	*Electronic Health Records/is, og, ut [Instrumentation, Organization & Administration, Utilization]
34	layout.ab. or layout.ti.
35	*Lighting/
36	*Heating/
37	*Humidity/
38	*Ventilation/
39	natural light*.ab. or natural light*.ti.
40	fluorescent light*.ab. or fluorescent light*.ti.
41	room temperature.ab. or room temperature.ti.

42	*Socioenvironmental Therapy/
43	OR (#20 – #42)
44	*Ecology/
45	*Environmental Health/
46	view nature.ab. or view nature.ti.
47	nature access.ab. or nature access.ti.
48	garden*.ab. or garden*.ti.
49	plants.ab. or plants.ti.
50	flowers.ab. or flowers.ti.
51	biophilia.ab. or biophilia.ti.
52	OR (#44 – #51)
53	#19 OR #43
54	#52 OR #53
55	#15 AND #54
56	limit 73 to (english language and humans and yr="2012 -Current")
	Results; n = 1664

Table 8. All EBM Database search

Search terms in All EBM Reviews: Cochrane Database of Systematic Reviews 2005 to August 30, 2017, Database Field Guide - Opens new tab EBM Reviews - ACP Journal Club 1991 to August 2017, Database Field Guide - Opens new tab EBM Reviews - Database of Abstracts of Reviews of Effects 1st Quarter 2016, Database Field Guide - Opens new tab EBM Reviews - Cochrane Central Register of Controlled Trials July 2017, Database Field Guide - Opens new tab EBM Reviews - Cochrane Methodology Register 3rd Quarter 2012, Database Field Guide - Opens new tab EBM Reviews - Health Technology Assessment 4th Quarter 2016, Database Field Guide - Opens new tab EBM Reviews - NHS Economic Evaluation Database 1st Quarter 2016	
1	Same search as above
2	Results: n = 158

Table 9. Summary of included peer-reviewed literature

Reference	Aim	Population/Setting	Intervention	Results
<p>Stiller et.al. [3] (SR and MA 2016)</p>	<p>To examine whether healthcare facility design is a contributing factor to multifaceted infection control strategies.</p>	<p>Hospital wards including Surgical, internal medicine, pediatric, Gen Med, Burn Centre. Majority ICU</p>	<p>Topic 1 – Accessibility of the antiseptic hand rub dispenser's (AHRD) location inside the patient's room</p> <p>Topic 2 – Influence of single patient rooms</p> <p>Topic 3 – Patient's room size</p>	<p>Topic 1: Accessibility of the antiseptic hand rub dispenser's location and hand hygiene compliance</p> <p>Study 1: The compliance rate of the two equally sized groups showed a significant difference ($p < 0.01$): 14 of 26 physicians in group 1 (53.8%) performed hand hygiene with the dispenser positioned adjacent to the patient, while in group 2 only 3 of 26 (11.5%) performed hand hygiene using the dispenser installed at the entrance door.</p> <p>Study 2: an increased hand hygiene compliance rate in department B following implementation of the bed rail system from 36.4 to 51.5% ($p < 0.01$), while the compliance rate in department A remained almost unchanged (36.4% vs. 35.9%). In a follow-up study conducted six months later, investigators recorded 70 uses of 255 opportunities (27.5%) in department A, in contrast to 80 uses of 302 opportunities (26.5%; $p < 0.01$) in department B over a time period of one month.</p> <p>Study 3: During this experimental period, an average daily product use of 214.8 g was determined without any statistically significant difference in comparison to the control period ($p = 0.2$).</p> <p>Topic 2: Single-patient rooms and healthcare-associated infections/colonization</p> <p>We identified a total of nine studies, in which single-patient bedrooms are compared with multiple patient bedrooms or with an open ward design with regard to the patient's acquisition of a healthcare-associated colonization with multidrug resistant organisms (MDRO) or infection with any pathogen. These nine studies examined the infectious outcomes of bacteremia, ventilator associated pneumonia, lower respiratory tract infection, gastrointestinal infection, infection of the eye and urinary tract infections.</p> <p>Six studies showed a significant benefit of single patient bedrooms in reducing the healthcare-associated colonization with MDRO and infection rate. However, three studies found that single-patient rooms are neither a protective factor nor a risk factor for colonization and HAI.</p> <p>A meta-analysis of these nine studies showed a significant benefit of single patient bedrooms in reducing the healthcare-associated colonization and infection rate compared with patient care in multiple patient bedrooms or with an open ward design (RR: 0.55, 95% CI: 0.41 to 0.74)</p> <p>Overall, the treatment of patients in a single-patient room seems to have a significant benefit in reducing the healthcare-associated colonization with MDRO and the infection rate with any pathogen compared to treatment in multiple patient bedrooms.</p> <p>Topic 3: Patient room size/proximity between patients and healthcare-associated infections/colonization</p>

Reference	Aim	Population/Setting	Intervention	Results
				Overall, a minimum distance between beds of $\leq 1\text{m}$ was a significant risk factor associated with health-care associated outbreaks of severe acute respiratory syndrome (SARS) at all participating hospital wards (OR 3.36, 95% CI: 1.38 to 8.16; P = 0.008)
Vetter et.al. [2] (SR and MA 2015)	To assess the effect of art (i.e., ambient features, interior design including visual art, and architectural features) on health outcomes	Surgical patients, inpatient and outpatient settings	All kinds of art, with a no-art exposure in surgical adult patients with clinically relevant outcomes:	Narrative Review on the Impact of Architectural Features, Interior Design, or Ambient Features on Patients' Health Few non-music related studies were found regarding the impact of different art forms on surgical patients. Overall, architectural features, providing a spacious, friendly, light-flooded hospital architecture may improve patient health, as measured by patient activity, pain, anxiety, and even mortality.
Drahota et. al. [1] (SR and MA 2012)	To assess the effect of hospital environments on adult patient health-related outcomes	Adult hospital patients	Environmental interventions	Interventions explored were: 'positive distracters', to include aromas (two studies), audiovisual distractions (five studies), decoration (one study), and music (85 studies); interventions to reduce environmental stressors through physical changes, to include air quality (three studies), bedroom type (one study), flooring (two studies), furniture and furnishings (one study), lighting (one study), and temperature (one study); and multifaceted interventions (two studies). No studies were found meeting the inclusion criteria to evaluate: art, access to nature for example, through hospital gardens, atriums, flowers, and plants, ceilings, interventions to reduce hospital noise, patient controls, technologies, way-finding aids, or the provision of windows.

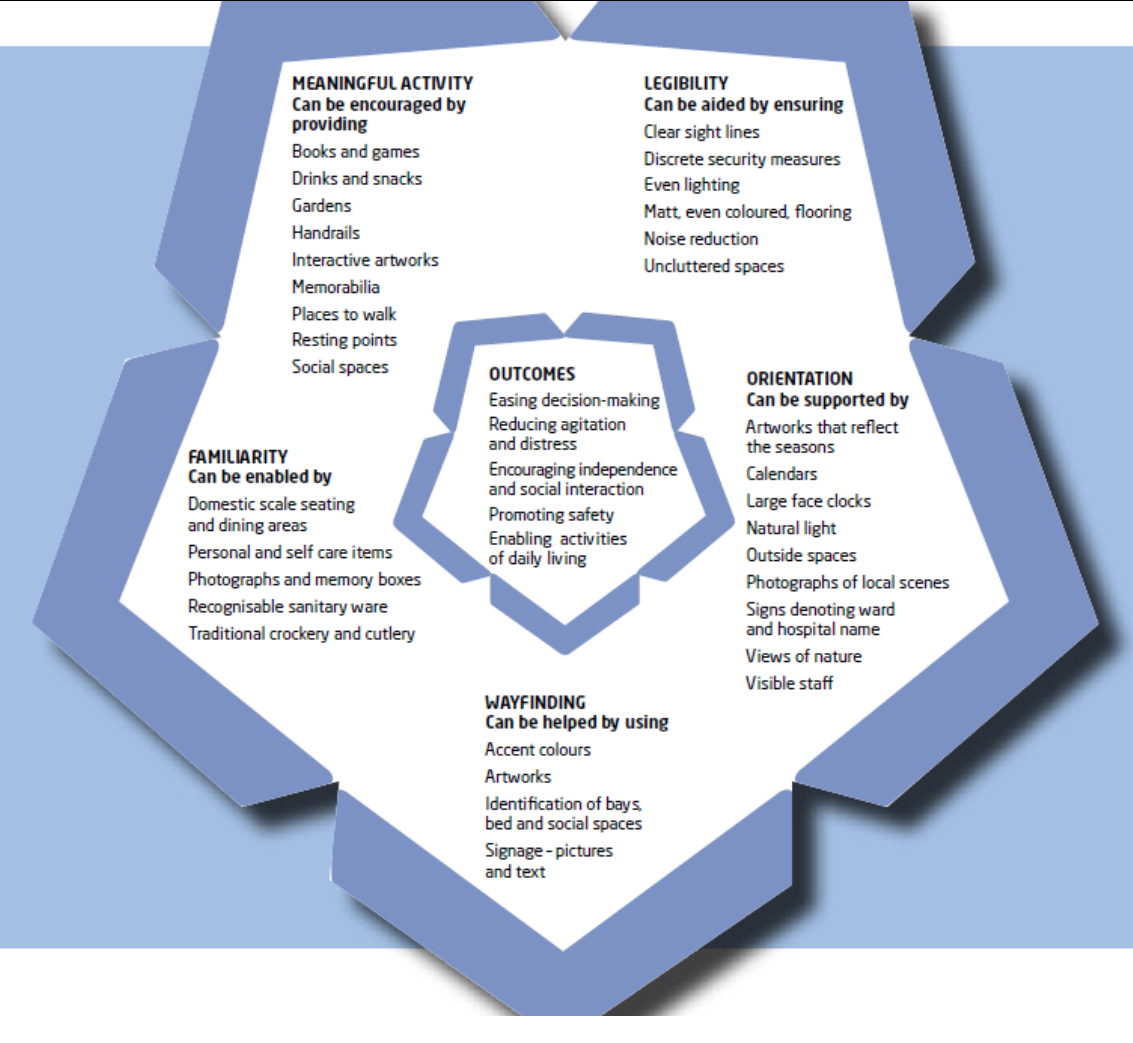
Table 10. Summary of included grey literature (i.e., including quality improvement studies from white papers)

Reference	Aim	Setting	Principles	Details
Australasian Health Facility Guidelines [7]	To be used as 1) benchmark for the designer 2) checklist for assessment of design and functionality 3) information for users	Healthcare facilities	Principles designed for access, mobility and OHS and security: <ul style="list-style-type: none"> • Flexible design • Rooms shared between units • Overflow design 	Planning Principles in Healthcare facilities (no explicit link references in content; no search or development methods) Flexible design - Flexible design refers to planning models that can not only adequately respond to contemporary operational policies but also have the inherent flexibility to adapt to a range of alternative, proven and forward looking policies. - Flexible design should address future trends and changes in patient profiles, e.g. cultural background and the increase in the number of bariatric patients.

Reference	Aim	Setting	Principles	Details
	involved in a project		<ul style="list-style-type: none"> • Staged usage • Zoning • Modular design • Single handing <p>Design interventions include</p> <p>Space standards such as</p> <p>Floor finishing</p> <p>Wall finishing</p> <p>Corner guards and crashrails</p> <p>Handrails</p> <p>Splash protection</p> <p>Benchtops</p> <p>Handwash facilities and tapware</p>	<p>- At the macro level, many of the commonly adopted planning models have proved flexible in dealing with multiple operational policies.</p> <p>- At the micro level, designers should consider simple, well proportioned, rectangular rooms with good access to simple circulation networks. Interior features should not be achieved by creating unnecessary complexity.</p> <p>Rooms shared between units</p> <p>The concept refers to models that allow for changes in operating mode as a function of management rather than physical building change. For example, two inpatient units can be designed back to back so that a range of rooms can be shared. The shared section may be capable of isolation from one or the other inpatient unit by a set of doors. This type of sharing is commonly referred to as 'swing beds'. It represents a change to the size of one Inpatient Unit without any need to expand the unit or make any physical changes.</p> <p>Designers should consider issues such as compatibility of use, access to treatment rooms, utility rooms, storage, etc and the supervision of patients when using swing beds or rooms, and in particular, the ability to switch nurse call systems to the new Staff Station.</p> <p>Overflow Design</p> <p>Some functions can be designed to serve as overflow for other areas that are subject to fluctuating demand.</p> <p>Staged Usage</p> <p>It is desirable to implement a staged usage policy to close off certain sections when they are not in use. This allows for savings in energy, maintenance and staff costs. It also concentrates the staff around patients and improves communication.</p> <p>Zoning for hours of operation and for security</p> <p>The design should collocate units with similar operating hours where appropriate, to allow easy shutdown of larger floor areas or even whole floors after hours. Create and maintain safe transit routes through the facility and ensure that it is not necessary for staff to traverse closed areas after hours.</p> <p>Modular Design</p> <p>This is the concept of designing a facility by combining well designed standard components. For example a designer may create a range of patient bedrooms, a range of utility rooms and other common rooms that are based on a regular grid such as 300 or 600mm. These rooms can then be combined to create larger units such as an inpatient unit. The inpatient unit can then be used as a module and repeated a number of times as required.</p> <p>Single handing</p>

Reference	Aim	Setting	Principles	Details
				Single handing refers to situations where the room plan is repeated, the term is also used for the layout of furniture and fittings e.g. medical services panels.
ACI – Aged Health Network [5]	<p>1) To describe the ten key principles that define an appropriate physical environment for the care of people with dementia in hospital</p> <p>2) To describe the use of audit tools to assist with identifying areas for improvement</p>	Patients with dementia in hospital	<p>Ten Principles:</p> <ul style="list-style-type: none"> • Safety • Size • Visual access • Stimulus reduction • Highlighting useful stimuli • Provision for wandering, circulation and access to outside area • Familiarity • Private and social spaces • Community links • Support values and goals of care 	<p>Ten Principles to define physical environment</p> <p>PRINCIPLE 1: Unobtrusively reduce risks People with dementia require an internal and external environment that is safe, secure and easy to move around if they are to make the best of their remaining abilities. However, obvious safety features and barriers will lead to frustration, agitation and anger and so potential risks need to be reduced unobtrusively.</p> <p>PRINCIPLE 2: Provide a human scale The scale of a building will have an effect on the behaviour and feelings of a person with dementia. The experience of scale is determined by three factors; the number of people that the person encounters, the overall size of the building and the size of the individual components, such as doors, rooms and corridors. A person should not be intimidated by the size of the surroundings or confronted with a multitude of interactions and choices. Rather the scale should help the person feel in control.</p> <p>PRINCIPLE 3: Allow people to see and be seen An environment that allows people to see their destination will help to minimise confusion. It should also enable staff to see the patient from where they spend most of their time. This assists with the monitoring of the patient and reassures the patient of their safety.</p> <p>PRINCIPLE 4: Reduce unhelpful stimulation Because dementia reduces the ability to focus on only those things that are important, a person with dementia can become stressed by prolonged exposure to large amounts of stimulation. The environment should be designed to minimise exposure to stimuli that are not helpful. The full range of senses must be considered. Too much visual stimulation, for example, is as stressful as too much auditory stimulation.</p> <p>PRINCIPLE 5: Optimise helpful stimulation Ensuring that those things that patient needs to be aware of are strongly highlighted will increase the chance of them being noticed and used. Providing multiple cues using vision, hearing, smell and touch will help to compensate for sensory losses.</p> <p>PRINCIPLE 6: Support movement and engagement Aimless wandering can be minimised by providing a well-defined pathway, free of obstacles and complex decision points, that guides people past points of interest and gives them opportunities to engage in activities or social interaction. The pathway should be both internal and external, providing an opportunity and reason to go outside when the weather permits.</p>

Reference	Aim	Setting	Principles	Details
				<p>PRINCIPLE 7: Create a familiar space The person with dementia is more able to use and enjoy spaces and objects that were familiar to them in their early life. The environment should afford them the opportunity to maintain their competence through the use of familiar furniture, fittings and colours. The involvement of the person with dementia in personalising the environment with their own familiar objects should be encouraged.</p> <p>PRINCIPLE 8: Provide a variety of spaces to be alone or with others People with dementia need to be able to choose to be on their own or spend time with others. This requires the provision of a variety of spaces that prompt a range of activities, e.g. reading alone, conversing with one or two others or engaging in larger group activities.</p> <p>PRINCIPLE 9: Provide links to the community Without constant reminders of who they were and are, a person with dementia will lose their sense of identity. The best people to remind them are their family and friends. The environment should therefore provide comfortable opportunities for visitors to spend time interacting with the patient.</p> <p>PRINCIPLE 10: Support the values and goals of care An environment that embodies the values and goals of care, e.g. provides opportunities for engagement with the ordinary activities of daily living to support rehabilitation goals, will assist the person with dementia to respond appropriately and the staff to deliver the desired care.</p>
Centre for Health Design [4]	Cross-sectional analysis using archival fall data to explore the role of the built environment on falls	12 hospitals (27 units) in the United States Exclude: Obstetrics and paediatric units		<p>Findings from this exploratory study suggest that environmental design may impact the number of patient falls.</p> <p>The following areas were explored:</p> <ul style="list-style-type: none"> • Spatial organisation environment <ul style="list-style-type: none"> ○ Bathroom design and orientation ○ Toilets ○ Bedroom flooring ○ Bathroom flooring ○ Grab rails ○ Visibility of areas and staff • Sensory environment <ul style="list-style-type: none"> ○ Noise levels ○ Distractions ○ Lighting

Reference	Aim	Setting	Principles	Details
<p>The King's Fund [6]</p>	<p>To create more supportive environments for people with dementia in hospital, grouped around desired outcomes</p>	<p>People with dementia in ward environments</p>	<p>The design principles highlight five key elements of supportive design:</p> <ul style="list-style-type: none"> • legibility (the ability to understand spaces) • orientation • wayfinding • familiarity • meaningful activity. 	 <p>The diagram illustrates five key design principles for a functional ward, each with a list of strategies to support it:</p> <ul style="list-style-type: none"> MEANINGFUL ACTIVITY Can be encouraged by providing: Books and games, Drinks and snacks, Gardens, Handrails, Interactive artworks, Memorabilia, Places to walk, Resting points, Social spaces. LEGIBILITY Can be aided by ensuring: Clear sight lines, Discrete security measures, Even lighting, Matt, even coloured, flooring, Noise reduction, Uncluttered spaces. ORIENTATION Can be supported by: Artworks that reflect the seasons, Calendars, Large face clocks, Natural light, Outside spaces, Photographs of local scenes, Signs denoting ward and hospital name, Views of nature, Visible staff. WAYFINDING Can be helped by using: Accent colours, Artworks, Identification of bays, bed and social spaces, Signage - pictures and text. FAMILIARITY Can be enabled by: Domestic scale seating and dining areas, Personal and self care items, Photographs and memory boxes, Recognisable sanitary ware, Traditional crockery and cutlery. <p>In the center of the diagram is a box labeled OUTCOMES with the following goals: Easing decision-making, Reducing agitation and distress, Encouraging independence and social interaction, Promoting safety, and Enabling activities of daily living.</p>